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UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

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# PROGRESS REPORT ON THE SUGAR PINE SCALE MATSUCOCCUS PAUCICICATRICES MORRISON, AS A PEST OF YOUNG AND MATURE SUGAR PINE TREES IN CALIFORNIA

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# PROGRESS REPORT ON THE SUGAR PINE SCALE, MATSUCOCCUS PAUCICICATRICES MORRISON, AS A PEST OF YOUNG AND MATURE SUGAR PINE TREES IN CALIFORNIA

## INTRODUCTION

Within recent years scale insects on pines have commanded greater attention than heretofore as possible major forest pests. The scales about which we have greatest concern include forms belonging to the genus Matsucoccus, family Margarodidae. Their attacks on ponderosa pine have been discussed in previous reports. (1 and 2).

On sugar pine, Pinus lambertiana, one of these forms was found doing considerable damage to young trees as recently as 1936. The scale, identified by Professor G. F. Ferris of Stanford University as a new species of Matsucoccus, was later (January 1939) named by Dr. Harold Morrison, Bureau of Entomology and Plant Quarantine, Division of Insect Identification, as M. pauci-cicatrices.

This insect was found to be associated with flagging injury and often with top-killing of sugar pine reproduction and pole size trees. The first damage of this kind was reported by Mr. G. R. Struble, Bureau of Entomology and Plant Quarantine, Division of Forest Insects, from Eight-Mile in Yosemite in June 1936, who later that same summer found that it was quite generally distributed in the Yosemite area, particularly in the vicinity of Mariposa Grove. Reports of damage together with specimens sent in by Drs. W. W. Wagener and J. L. Mielke, Bureau of Plant Industry, Division of Forest Pathology, working in northern California during August and October 1936, indicated that this insect was distributed throughout the Siskiyou and Shasta National Forests. Thus it was learned that this insect was rather widely distributed in the sugar pine forests in California.

Because of the wide spread of this scale insect and its apparent damage to second growth sugar pine as well as its known presence in a few mature pines (the actual prevalence in mature sugar pine yet unknown), and because of its importance in connection with scouting for Blister Rust, it has been deemed advisable by the Bureau of Entomology and Plant Quarantine, Division of Forest Insects, to initiate studies on this insect. A field plot has been set up near the Miami Laboratory on the Sierra National Forest in California to determine the effect of scale feeding over a period of time. The plot is on lands cut over some 30 years ago and includes only trees in the younger age classes. Artificial infestation studies have been made on young seedling sugar pines held in the Berkeley insectary. Preliminary life history observations have been conducted at both the Miami and Berkeley laboratories.

## HOSTS AND DISTRIBUTION

So far as is known, Matsucoccus paucicicatrices Morrison appears to belong to the white pine group of Margarodid scale species. It was originally collected from young sugar pine, Pinus lambertiana, at Eight-Mile, in Yosemite National Park, California. Morrison (3) records it from the following hosts and localities: on herbarium material, Galice District, Rogue River National Forest, Oregon, and Siskiyou National Forest, Oregon; on Pinus monticola, Chagoopa Plateau, Upper Kern River, California; on Pinus flexilis, Old Marias Pass (E. slope), Montana; from herbarium material, Elk Mountain, Saratoga, Wyoming; and on Pinus sp., Rimrock Crater at the Palisades, Crater Lake National Park, Oregon. In addition to the above hosts and localities it has been taken by the author on sugar pine in California on the Lassen and Shasta National Forests.

## CHARACTER OF DAMAGE

The needles of a sugar pine branch that is going to die or flag, as a result of scale insect feeding, will commence fading usually during the spring of the year. The needles are pale green at first and as the season progresses they turn straw-colored and finally a deep sorrel (Figure 1).

Figure 1. (9884) A flagged twig collected from the upper crown of a young sugar pine on the Sierra National Forest in California. Large branches that arise from the main bole, particularly in the upper crown of young trees, are often killed outright.

As a general rule, dead needles will remain intact with the stem during the summer and fall seasons and oftentimes will be retained into the following year. There is more of a tendency for small branchlets to flag than there is for large branches themselves. When all of the branchlets on a single branch are killed, however, the large branch itself will perish also. Infestations of this scale insect are common on the trunks of young trees, particularly in the upper crowns.

The scale insects apparently prefer to settle on the main bole and branches in the upper crown of the tree. Stems that are scale infested will show considerable resining and cracking of the bark (Figure 2). On the main

Figure 2. (11129A) Infestations of the sugar pine scale, Matsucoccus paucicicatrices on stems cause much bark cracking, swelling (particularly in the area of the nodes), and resining that appears as globules on the bark surface.

bole the scale congregate in large numbers under the bark scales about the nodes from which lateral branches arise as well as around nodes on the stems and branches themselves. When the scale settle in large numbers about a node there is a decided swelling and a copious flow of resin in the immediate vicinity of the insects (Figure 3). This resin flow tends to "pitch-out" the scales and also form a resin lesion where the branch arises from the node, and this lesion kills the branch (Figure 4). Nodes on lateral branches that are heavily infested with scale insects likewise cause lesions that ultimately kill the branch. These flagged sugar pine branches have, apparently, already been confused with those commonly associated with blister rust.

Figure 3. (9898) Left: Where the Matsucoccus scale settle in large numbers about the nodes on branches and bole of young sugar pine, there is a decided swelling and cracking of the wood tissue and also a copious flow of resin in the immediate vicinity of the insects. In areas thus affected there will be a resined lesion produced that kills the branch. The resin flow will many times "pitch-out" and kill the scale insects.
Right: Uninfested green node on sugar pine branch.

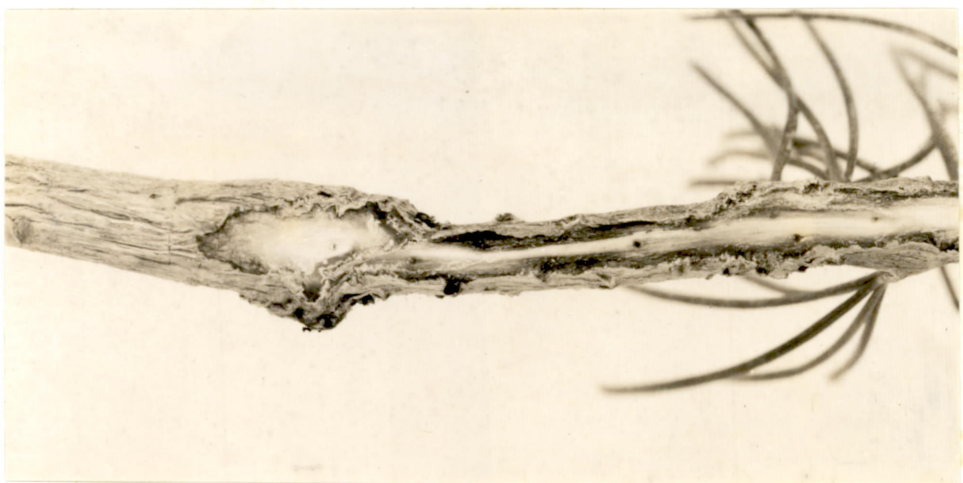


Figure 4. (9885) A swollen node on a flagged branch and the primary lesion that caused the branch to die. Complete lesions are usually associated with swollen nodes produced by large aggregations of feeding Matsucoccus scale.

## LIFE HISTORY AND HABITS

### Spring migration of adult females

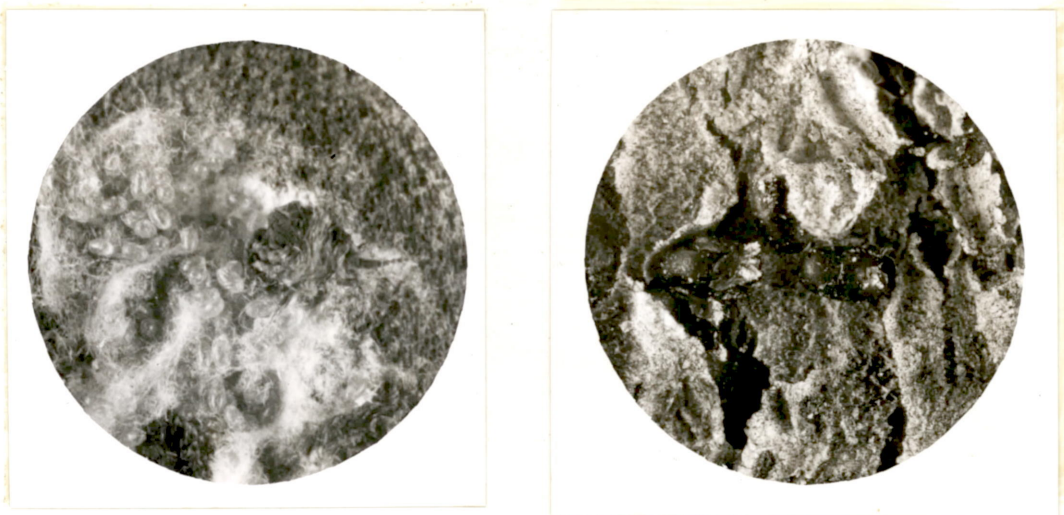
In the early spring, usually April, many adult females of this scale may be observed shoving their way out of the overwintering preadult bodies found in bark cracks on twigs, branches and on the main bole, particularly in the upper crowns, of young sugar pines. The females (length 2.7; width 1.1 mm) are sluggish in action and there appears to be no inclination to settle on the twigs or branches. There is, however, a definite migration of these females from the twigs to the main bole and down the trunk of the tree where they later settle under the bark scales.

### Male scales

No biological evidence yet obtained, although males are definitely known to be present and it is assumed, therefore, that mating taks place.

### Egg laying

After settling beneath the bark scales on the main trunk, the females commence secreting wax and laying eggs (Figure 5A). The egg laying



A B

Figure 5. A Left: (11091D) Matsucoccus paucicicatrices adult female and egg mass found under bark scales on the main bole of young sugar pine on the Sierra National Forest in California. The female scale migrate in the spring from the branches down the tree trunk and settle under the bark scales thereon.
B Right: (11091B) Larvae or preadults of the sugar pine scale, Matsucoccus paucicicatrices, on the stems of young sugar pine.

period occurs usually during May, depending on climatic conditions. As many as 200 eggs have been observed in the waxy secretions of a single female, although the average was 150. The individual egg is exceedingly small and is almost invisible to the unaided eye, the egg mass itself being quite conspicuous. The incubation period of the eggs appears to vary from 15 to 30 days, again depending upon climatic conditions.

Larval development

After hatching from the eggs the first stage larvae migrate, usually during early June, back up the tree trunk where many settle on the main bole in the upper crown. Others migrate out onto the branches and twigs where they congregate in large numbers, particularly about the nodes on stems. The duration of the first instar is unknown, but preliminary evidence as based on the few specimens collected at the Berkeley insectary indicated that it terminates in approximately one month (during June or July). The second instar appears to require approximately two months from late July through August and into early September; and the early preadult appears during September and continues to mature throughout the remainder of the season, finally overwintering in this stage of development (Figure 5B).

## RELATION OF SCALE INSECTS TO FLAGGING

Internode and node counts

Scale population counts were made on internodes of green and flagged twigs in an effort to determine if large numbers of scale were ever present on flagged branches and conversely. The scale counts presented erratic results and there was apparently no definite correlation with regard to heavy populations on the internodes of flagged branches. This correlation did exist, however, when heavily infested nodes along the main bole, stems and branches in the upper crowns of trees, were taken into consideration. Twenty nodes, half of which were cut from green stems and lightly infested, and the other half cut from flagged stems heavily infested with scale insects, were measured according to length and diameters of the node. The population counts of scale on these two types of nodes were made under the low power binocular microscope. Since the measurements for each selected node were so different, the area of each node was figured in square inches and the number of scale per square inch for each sample was, as a consequence, easily calculated. Heavily infested nodes on flagged branches possessed an average of 5.06 scale insects per square inch; while only 2.39 scale per square inch were found on lightly infested nodes from green stems. In other words, there were more than twice the number of scale insects on nodes selected from flagged branches as from those cut from green stems.

Demonstration experiment

On May 24, 1939 several potted sugar pine seedlings were artificially infested with Matsucoccus paucicicatrices scale. Some of the artificially infested trees were held in the Berkeley insectary while others were placed on a small sun porch just outside the Berkeley Laboratory. At the insectary three of the sugar pine seedlings were infested by placing adult females with egg masses* in small thimble-shaped copper screen wire baskets and fastening these securely to the stems by means of a fine strand of copper wire. One check with copper baskets and no scale eggs was also retained at the insectary. On another sugar pine reproduction, sticky-band barriers were used to restrict the scale to a certain portion of the main stem and several copper baskets filled with egg masses were fastened between these barriers. One sticky-band barrier check was also set up. On the sun porch at the Berkeley Laboratory three more sugar pine seedlings were grossly infested with this scale insect using the copper basket method, and one reproduction was held as a check.

On November 13, 1939 the branches of one of the grossly infested sugar pines at the insectary commenced flagging (Figure 6), a period of only six months being required for the scale insects to cause injury to the tree. It is suspected that some of the other artificially infested seedlings will likewise flag during the 1940 season.

Field plot studies

A field plot, .33 of an acre in area, was established on the Sierra National Forest (see map, Figure 7), during April 1939, in order to determine just what effect Matsucoccus paucicicatrices scale feeding has upon second growth sugar pine over a period of time. There were 115 trees selected for the study and each tree was marked with a metal numbered tag, and on a mimeographed form classified as to crown class, crown density, D.B.H., approximate height, and the number of flags per year. On five of these trees (Nos. 1, 2, 22, 25 and 49) fifty scale infested green twigs were tagged and sketched with pencil in spaces provided on the mimeographed form. This was done to see if heavily infested and swollen nodes on the stems would later form lesions and cause death to the branch. Although a few of these branches, the nodes of which were much swollen and heavily infested with scale insects, flagged during 1939, the gross results of this experiment will not become available until during the 1940 season.

On six of the experimental trees (Nos. 2, 4, 22, 26 and 29), flag readings were taken during the 1939 season in order to obtain some idea as to the sequence of branch killing as caused by this scale insect. Evidence

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* The adult females with egg masses were collected beneath the sugar pine bark scales on the trunk with portions of the bark remaining intact with the insects, thus facilitating transfer.

Figure 6. Right: (11201) Seedling sugar pine artificially infested May 24, 1939 with Matsucoccus paucicicatrices scale. On November 13, 1939 some of the infested branches on this potted tree commenced flagging, a period of only six months being required for the scale insects to cause injury.

Left: (11201) An uninfested (check) sugar pine seedling held under the same environmental conditions as the artificially infested tree on the right.

Figure 7

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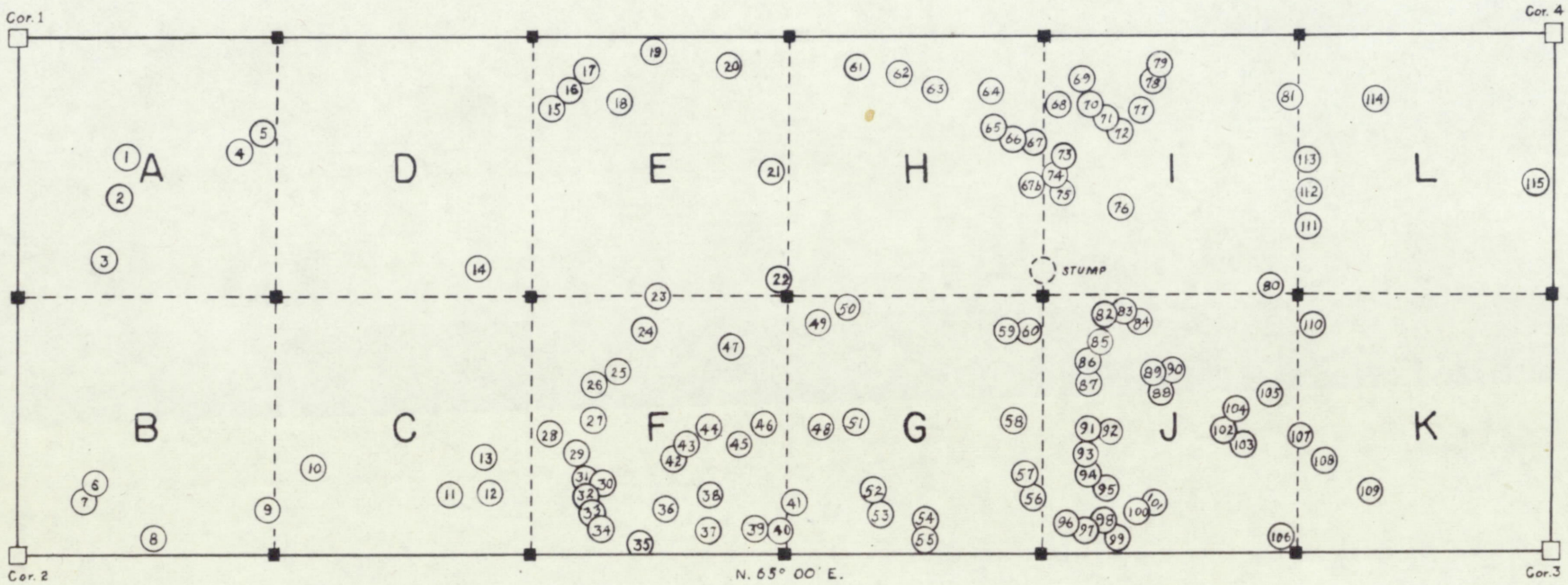
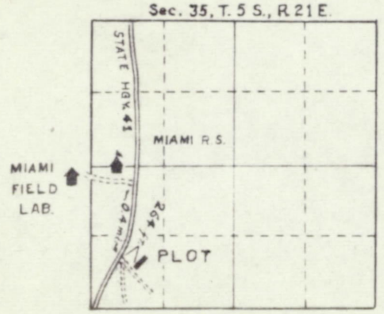
# SUGAR PINE MATSUCOCCUS STUDY PLOT NO. 1

SIERRA NATIONAL FOREST
SW¼, SW¼, SEC. 35, T 5 S, R 21 E, M.D.M.
EST. APRIL 13, 1939. MILLER AND MCKENZIE




REGIONAL LOCATION

## LEGEND

—— PLOT BOUNDARY

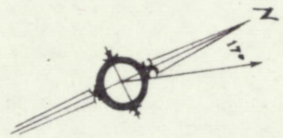
---- COMPARTMENT BOUNDARY

B COMPARTMENT DESIGNATION

○ TAGGED AND NUMBERED SUGAR PINE TREES

□ EXTERIOR CORNER 4x4" REDWOOD STAKE

■ COMPARTMENT CORNER 2x2" REDWOOD STAKE




SCALE

0 0.1 0.2 0.5 chain

on the basis of this preliminary test indicates that branch flagging tends to be most severe during the early part of the season, although some flagging persists more or less throughout the whole season (Table 1).

Table 1.

Sequence of Branch Flagging on Six Experimental Sugar Pines on Plot 1.

| Date of Reading | Number Flags Observed | Percent of Total for Season |
|---|---|---|
| April 14, 1939 | 157 | 70.6 |
| June 30, 1939 | 33 | 14.9 |
| July 27, 1939 | 19 | 8.6 |
| Aug. 28, 1939 | 13 | 5.9 |
| Total for Season | 222 | 100.0 |

Early flagging is to be expected since the scale insect has reached maturity by spring and the full compliment of damage as caused by the feeding larvae is attained.

## ECONOMIC IMPORTANCE

On the basis of observations made in the field, Matsucoccus pauci-cicatrices apparently has a definite weakening effect on younger trees from sapling to pole size, and many have been killed outright as a result of the scale feeding. It is common to observe at least 25 percent top killing by this insect on the young sugar pines on the Sierra National Forest in California. Infestations of this scale appear to be associated with conditions of highly competitive growth. A canopy-like situation produced by larger trees overhead seems to be extremely desirable for developing scale insects. Flagging injury is more prevalent under these growing conditions. Sugar pine growing in rather poor sites have also been found to be highly susceptible to flagging and scale insect attack.

The crowns of mature pines are also attacked by this scale insect and flagging has been noted on these big trees. Preliminary observations indicate, however, that the larger trees are less affected by this scale than is the second growth type, unless the scale feeding on the mature pine branches is connected with a gradual decadence which renders the trees more susceptible to bark beetle attacks. This phase of gradual decadence as caused by the activities of this scale will be more fully investigated in the future.

SUMMARY

Matsucoccus paucicicatrices Morrison was described from flagged branches collected from second growth Pinus lambertiana on the Sierra National Forest in 1936.

Apparently these sugar pine flagged branches have been confused with those commonly associated with blister rust.

The principal host of this scale insect is sugar pine, although it has been collected from Pinus monticola, Pinus flexilis and from herbarium specimens of the genus Pinus. The scale has been collected on pines in California, Oregon, Montana and Wyoming.

The needles of a branch that is going to die or flag as a result of scale feeding will turn pale green at first and as the season progresses will turn straw-colored and finally a deep sorrel. There is more of a tendency for small branchlets to flag than for large limbs.

When the scale settle in large numbers about the nodes on branches (particularly in the upper crown) there is a decided swelling of the nodes and a copious flow of resin in the immediate vicinity of the insects. This resining ultimately causes lesions that kill the branch.

A year's time is required for this scale to complete its life cycle. Adult females emerge in the spring from overwintering preadults, migrate down the tree trunk and eventually settle beneath the bark scales thereon. Eggs are laid in waxy secretions produced by the females. The first stage larvae migrate back up the trunk and out onto the branches and twigs where they finally settle. Several molts occur, the last of which gives rise to an apodous larval preadult. The scale insect overwinters in this stage of development.

There are twice the number of scale insects on swollen nodes of flagged branches as on those occurring on infested green stems.

Artificial planting of Matsucoccus paucicicatrices scale on sugar pine reproduction resulted in subsequent branch flagging.

Actual flag counts made on experimental trees throughout the 1939 season indicate that branch flagging tends to be most severe during the early part of the season, although some flagging persists more or less throughout the whole year.

Matsucoccus paucicicatrices scale apparently has a definite weakening effect on young trees from sapling to pole size.

Preliminary observations indicate that larger trees are less affected by this scale than is the second growth type.

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3. Morrison, H. 1939. Descriptions of New Species of Matsucoccus (Hemiptera: Coccidae). Ent. Soc. Wash. Proc., Vol. 41, p. 14.